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THE ANNUAL COST OF THE EASTERN IRRIGATION DISTRICT

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ALBERTA IRRIGATION STUDIES
VOLUME III

PREPARED BY:
ALBERTA REGIONAL
ENGINEERING DIVISION

CALGARY, ALBERTA
MAY, 1965

PRINTED BY ARDA (CANADA AND ALBERTA)

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THE ANNUAL COST
OF THE EASTERN IRRIGATION DISTRICT

INTRODUCTION

In order to determine the actual costs of operating an irrigation project and to gain a greater knowledge of the manner in which benefits accruing from irrigation projects are distributed throughout the economy, an engineering and economic study of irrigation in the Province of Alberta has recently been initiated. The study is to be carried out in three phases:

(1) An engineering study to determine the costs of operating, maintaining and rebuilding the irrigation works. This is being undertaken by the Canada Department of Agriculture, through the Prairie Farm Rehabilitation Administration.

(2) An economic study to determine the primary benefits of irrigation, i. e., the value of production from irrigated land compared to that from non-irrigated lands in areas having similar soil and climatic conditions. This is being done by the Economics Division of the Canada Department of Agriculture.

(3) An economic study to determine the secondary benefits of irrigation, i. e., to determine how the benefits are distribut-

ed among different segments of the economy. This is being carried out by the University of Alberta, Department of Agricultural Economics, which also has the assignment of bringing the three phases of the study together.

This report represents the phase one portion of the study with reference to the Eastern Irrigation District, which has been chosen as the initial project to be examined.

SYNOPSIS

A cost analysis of the operation of the Eastern Irrigation District has been made by an examination of --

(1) The District's annual reports and financial statements.

(2) The condition of existing works and their cost of replacement.

The analysis has shown that the annual cost of operating this irrigation project on the basis of 1963 dollar values is $4.43 per irrigable acre, which includes provision for the perpetual upkeep of all works and the replacement, at periodic intervals, of all non-permanent structures and buildings.

The delivery of water in adequate quantities to all users must be assured. This will require the immediate implementation of a planned program of major structure replacement based on a detailed appraisal of all major structures in the system. Additional storage is required to assure an adequate water supply to the present acreage and is necessary to the further extension of the irrigable acreage. A study is required to determine the optimum additional internal storage re-

lated to main canal capacities and a comparative study of the benefits of external storage on the Bow River.

TERMS OF REFERENCE AND SCOPE OF WORK

By letter dated January 29, 1964, the Chief Engineer of the P.F.R.A. instructed the Alberta Regional Office to proceed with Stage (1), the engineering phase, of an overall study of the economies of irrigation in Alberta, the aims of which have been briefly outlined in the Introduction of this report.

The purpose of the engineering phase is to determine the cost of maintenance, operation, and replacement as required, of irrigation works, and may be subdivided into two parts.

(1) Inventory of irrigation works in Alberta to indicate the condition, probable life and necessary renewal of such works including headworks, main canal conveyance structures, distribution systems and drainage systems.

(2) The determination of the average annual expenditure necessary to maintain, operate and replace these works.

SOURCES OF INFORMATION AND METHODS OF PROCEDURE

Bearing in mind that the primary purpose of this report is to determine the cost of operating the Eastern Irrigation District, it was obvious that the records of the District must be studied over a certain period of time and that the physical condition of the works must be determined.

A period of 29 years, 1935 to 1963 inclusive, was selected for the analysis of costs. This period coincides with the period the project has been operated as a District under the Irrigation Districts Act. Considerable time was spent examining the books of the District and it was soon evident that most information pertinent to the study could be obtained from the District's annual reports. This section of the study proceeded using these reports for basic information, with additional clarification requested from the District when needed.

To determine the condition of the works extensive field inspections were made by P. F. R. A. personnel. The structures with an estimated replacement cost in excess of $20,000 each were classified as major structures. A list of 37 major structures was compiled. Each of these structures was individually examined in the field, their remaining service life was estimated, and through the use of element designs their present day replacement cost was estimated. In assessing the condition of some of these structures, use was made of a core drilling

program carried out in 1961 and 1964 by the P. F. R. A.

There are 499 bridges and 1, 199 culverts on the project. Of these, 216 bridges and 58 culverts, including all of the larger structures of both types, were inspected as to conditions.

Out of a total of 342 miles of major canals, about 150 miles were examined in the field. Three lateral systems, representative of the distribution system as a whole, were thoroughly examined. Portions of the drainage system were inspected and the condition of spillways and erosion control structures thereon was determined. All major reservoirs were visited, to determine the condition of the dams and dykes. Proposals for providing urgently required additional storage were briefly considered, making use, in some cases, of information taken from earlier investigations by the P. F. R. A.

DESCRIPTION OF THE PROJECT WORKS

General Features:

The Eastern Irrigation District, as is shown in Figure 1, lies about midway between Calgary and Medicine Hat, being bounded on the north by the Red Deer River and on the south by the Bow River. The head office of the District is in the centrally located Town of Brooks, about 120 miles east of Calgary on the C. P. R. main line and the Trans-Canada Highway.

The water supply for the project is diverted from the Bow River at the Bassano Dam located about four miles south-west of the Town of Bassano. From here the Main Canal follows a natural depression for four miles to the Little Dam Pond where it divides into two branches. The North Branch, which is the smaller of the two, serves the Bassano and Gem areas. The East branch serves the Springhill, Bow Slope, Antelope Creek and one or two smaller areas, and terminates at Lake Newell, the project's largest reservoir. This reservoir, in turn, supplies water to two further main canals: the Rolling Hills Canal serving the Rolling Hills area, and the Bantry Canal which carries water via the Brooks Aqueduct across a two mile wide depression to serve the Tilley and Bantry areas.

The total area of land irrigated in 1963 was 192,324 acres, an increase of about 80,000 acres since the project was taken over from the C.P.R. in 1935. It is estimated by District officials that a further 41,000 acres could be developed under gravity flow and an additional 35,000 acres under pumping lifts of 10 to 15 feet, provided the water supply could be firmed up through the construction of additional storage reservoirs. At the same time consolidation of present development should be considered in future planning.

Figure 2 shows the general layout of the project, indicating the lands now irrigated and the location of possible additional extensions.

The Canal System:

The Eastern Irrigation District had, in 1963, 342 miles of major canals defined for the purpose of this report as those having a capacity in excess of 50 c.f.s., most of which have been conveying water for 50 years. Considering the length of time these canals have been in service and the probable inadequacy of the design standards used in their construction as compared to present day standards, these canals are in remarkably good condition. However, canal deterioration in the form of bank scouring and sloughing, silt deposition and weed

growth, is evident in many locations in spite of a continuing maintenance program being carried out by the District in an effort to keep ahead of the situation.

Bank scouring has occurred where the natural soil through which the canals pass and from which the banks are constructed contains a high portion of fine particles which are readily eroded by the flowing water. It is more predominant in curved sections of the canals but is evident in some straight stretches as well. There is also evidence of bank sloughing which occurs when soil along the steep face of a previously scoured bank becomes saturated and slides to the bottom of the canal often as a result of frost action.

Silting has occurred in those portions of the canals where water velocity is low and is evident along the inside bank of canal curves, immediately upstream of check structures and, in some cases, along entire stretches of canal bed. . An example of the latter can be found in the North Bantry Canal which was constructed to a very flat gradient in an effort by the original designers to keep the land "under the ditch" to a maximum. Although most of the deposited silt undoubtedly is caused by the bank scour, it has been suggested that as the reservoir at the Bassano Dam has filled some silt may now be carried in from the river. There was no evidence, however, in the winter of 1963-64 of silt de-

position in the Little Dam Pond through which water flows slowly enough to permit sedimentation if silt were present.

The District has carried on a continuing program of silt removal, but it is apparent that this program should be increased as it has not kept pace with the rate of silt bank formation. Weakened canal banks have been periodically reinforced and, in addition to this, the District has for some time carried on a program of riprapping the more seriously eroded banks with willows to prevent further erosion, a program which has been quite effective. In addition, the District has constructed several canal cutoffs and relocations which have resulted in improved gradients and alignment. All of the more obvious relocations have now been made, but further investigation may indicate others which would be feasible.

Aquatic weeds are a problem in some canals, particularly those where silt has been deposited. These weeds grow rapidly in warm water, substantially reducing the carrying capacity of canals, sometimes to a stage requiring immediate remedial action if canal capacities are to be maintained. The District attacks the problem through the application of water borne weed killing chemicals and by chain dragging the canal beds. The program of weed control must be continued.

A large amount of land adjoining canals has been damaged from canal seepage. The initial damage in most cases occurred during the early years of the project operation, and very little additional land is now being affected. No seepage prevention program of any consequence, such as canal lining or toe drain installation, has been carried out by the District. Damaged land, where irrigable, has simply been reclassified as nonirrigable. Restoration of these lands to production is not considered to be economically feasible at the present time, in the majority of cases, nor is a major seepage prevention program likely to be warranted in the near future.

In summary, a stepped up program of canal rehabilitation and possible relocation in isolated instances is now required to restore the main canals to satisfactory condition. An approximate estimate of the amount and cost of this work will be found on Page 38 of this report.

Major Structures:

The 37 structures, which have been classed as major, are listed in Figure 3 which indicates their location, present age, estimated remaining life and estimated replacement cost. Several of the structures are relatively new, the District having found it necessary to replace the original structures in some cases, while in other cases

additional structures have been built as a result of revisions and expansion to the system.

All of the structures were examined in the field, and sample cores were taken from some of them to more accurately assess the condition of the concrete. From this examination it has been concluded that the average serviceable life of concrete structures built in the period of original project construction is 50 years. The notable exception to this is the Bassano Dam which is considered to be basically sound after 50 years of operation, although portions are now in need of extensive repair. In general, the larger structures are in better condition than the smaller ones which can be attributed both to the greater resistance to deteriorating forces possessed by larger concrete sections and the possibility that better inspection and quality control for the larger structures was used at the time of construction. The physical examination indicates that many structures require early renewal and that some, because of their relative importance, are in critical condition and require immediate attention. A suggested program of priorities for replacement is given in Appendix F of this report.

A detailed description of each of the 37 major structures is not included here, but the condition of the key structures is described briefly in the following paragraphs.

The Bassano Dam, which is the main diversion structure on the Bow River, has a reinforced concrete overlow section 60 feet in height and 720 feet long, a reinforced concrete headgate, and an earthfill dyke 7,000 feet long. It was built during the years 1912-14 at a cost of about $1,500,000. The estimated replacement cost today is $6,000,000. Maintenance costs before 1935 are unknown, but since that time have amounted to only $27,000 or about $1,000 per year. In addition, a further $20,000 has been expended on structure improvements.

The coring program carried out by the P.F.R.A. in 1961 indicates severe deterioration in the downstream wing walls and in portions of the overflow and chute section. In addition, extensive repairs are required to the gates and the upstream slope protection of the dyke. Provision for emptying the reservoir is also needed. Estimated cost of these repairs and additions is $1,800,000 which if undertaken now, should extend the life of the structure at least another 25 years. This dam is the key structure on the project, without which the District could not operate.

Another important structure is the Brooks Aqueduct, a reinforced concrete structure about 2 miles long, having a catenary bowl supported on beams and pedestals, inlet and outlet structures, and an inverted syphon under the C.P.R. main line. It was built in 1912-14 at

an original cost of $700,000. Repair costs have been high on this structure, amounting to over $90,000 in the past 11 years, mostly incurred in the replacement of portions of the invert section of the bowl. In addition, the District finds it necessary to close down the Bantry Canal, of which it is part, for 2 weeks in late August or early September of each year to carry out inspection and urgent repairs on the aqueduct.

The footings and support columns of this structure have been cored by the P.F.R.A., the results indicating that 35% of the footings are in poor condition, which would seem to rule out the possibility of salvaging any part of the existing structure. A number of replacement proposals have been investigated, including a new aqueduct, an earthfill, a syphon, pumping proposals, and various combinations of these. The most economical of the proposals would appear to be one involving the building of a new aqueduct over the deep portions of the valley, the construction of an earthfill over the shallower portions, and a new syphon under the C.P.R. tracks. The cost of this work, based on preliminary information, is estimated to be $1,300,000. The aqueduct is a key structure for water conveyance to about 57,000 acres of irrigated land. Because the capacity of the present structure is inadequate to serve the presently developed lands below it and because

much of the land to which irrigation may be extended in the future is downstream of the aqueduct, full consideration must be given to providing for future as well as present demands when rebuilding is undertaken. Because of the present condition and vital importance of this structure, early replacement to safeguard satisfactory project operation is necessary.

There are two large semi-circular wooden flumes on the project, the Crawling Valley flume on the North Branch Canal and the Lathom flume on the Springhill Canal. Both are reaching critical condition although useful life could be extended about 5 years with careful maintenance. The Crawling Valley flume would not be required if the proposed Crawling Valley reservoir were constructed, in which case it could be dismantled and the staves used for repairing the Lathom flume, thereby extending its life a few more years at no cost for materials. Consideration might be given to the replacement of Lathom flume with an earthfill although preliminary investigations indicate a lack of suitable material in the near vicinity.

The materials in many of the other larger structures appear to be in reasonably good condition, but the design of these structures was inadequate, particularly with respect to cutoff walls. This applies primarily to the two outlet structures from Lake Newell and to a lesser

degree to the North Branch and East Branch Canal Headgates. These structures should be rebuilt at an early date, as they are all vitally important to the operation of the project.

Major Bridge Structures:

For the purpose of this report, major bridges are defined as those in excess of 20 feet in length. Also included in the definition are culverts or combinations of same having a total hydraulic capacity equal to or greater than that of a 60 inch corrugated metal pipe. In general, bridges and culverts of this size are located on the major canals, although a few are located on the upper ends of distributary canals and on large excavated drainage ditches. Bridges over natural drainage channels are not considered in this report, as these channels at times carry runoff waters to which irrigation does not contribute and would have to be bridged in any case.

Using the above definitions, the total number of major bridge structures in the District is 91, located as shown on Figure 4. Ten of these structures are large culverts, the remaining 81 being bridges of timber, concrete or steel. Of these, it is suggested that 28 bridges, located on road allowances which are seldom used, could be abandoned.

Eleven of the 28 are served by slightly used trails, while the remaining 17 have no road leading to them. These bridges were built during the original construction of the project under a policy of placing a bridge at each road allowance. The land on either side of them has never been used for anything other than grazing, and it would appear that the bridges could be abandoned when they reach the end of their useful life and be reconstructed only if further land development takes place. The elimination of these 28 bridges, located as shown on Figure 4, would reduce the number of major bridges requiring perpetual maintenance to 53.

Until recently, the District has been responsible for the construction, reconstruction and maintenance of all bridges and culverts on the main and lateral canals at road allowances within the district. However, because of the great increase in volume and weight of vehicular traffic and the greatly improved standards of today's roads, it has been necessary to replace the old bridges with much stronger, more costly structures. The Eastern Irrigation District, together with the other irrigation districts in the province, have long felt that the cost of these structures should be borne by the public at large rather than by the water user. As a result of negotiations with the provincial and municipal officials regarding the problem, the District has now concluded an

agreement with the road authorities which divides the responsibility for the future construction, reconstruction and maintenance of all bridges and culverts on the District's works in accordance with a schedule established by the District, the County of Newell and the Province of Alberta.

Under this schedule the District's responsibility for major bridge structures is limited to those on "local" roads. Bridges on roads designated as District Highways will become the responsibility of the County, while those on main and secondary highways will be the responsibility of the Province. This will reduce the number of bridges which the District must now maintain to 52 and the number of large culvert structures to 3. If, as suggested earlier, the District abandons 28 of the bridges, the number requiring perpetual replacement by the District is further reduced to 24.

From a field examination, it has been concluded that of these 24 bridges, four require immediate replacement, four should be replaced within the next 5 years, 13 should last 10 to 15 years, while the remaining three, having been recently constructed - largely from precast concrete - should have a life expectancy of 30 to 40 years.

Figure 4 indicates the location of local, district and provincial highways and lists the number of structures for which each authority will be responsible. A more detailed breakdown of bridges and culverts as to responsible authority is given in Appendix D. Replacement cost estimates are also included in Appendix D.

Reservoirs:

The topography of the Eastern Irrigation District is such that water storage sites are not plentiful and most of those that do exist are wide, shallow prairie valleys that are expensive to develop and when developed create comparatively inefficient storages. During the original construction period, no river storage was provided - Bassano Dam is, in effect, simply a diversion weir, and only one offstream storage reservoir, Lake Newell, was constructed, though several other smaller storages were investigated by the C. P. R. Some of these reservoirs were investigated only as recreational developments.

As time went on, additional storages within the project were completed, details of which are shown on Figure 5. All of the existing storages are performing a useful task, but most of them are so small that they cannot be considered as anything but balancing pools. At the

present time approximately half of the District's 192, 324 developed acres have no storage above them and are entirely dependent on river flows, while the remaining half are partially so dependent.

Yearly yields of the Bow River are ample to supply all present needs if the water was in the right place at the right time, but this, considering the present facilities, cannot always be accomplished. Flow in the Bow River varies widely with the seasons and while power developments above the Eastern Irrigation District intake gates definitely improve the regulation of the stream in the overall picture, there are two periods of the year when low water in the river is liable to affect the operation of the District. The first of these periods is between the spring breakup and the June period of high water and is usually of comparatively short duration. Irrigation demands, while not at their peak, are usually significant, and in this period too, Eastern Irrigation District reservoir reserves are built up as much as possible.

The second period of danger of the District is after the high water in June. This period is often more protracted and, if there are no fall rains in the mountains, may last through September and on to the water diversion cutoff date, usually about mid-October. During this second period, the Calgary Power Company is often attempting to

keep its reservoirs built up for winter operation. The Bow River Project needs water to replenish its storages which have been depleted during summer peak demand periods. The Western Irrigation District, which has no storages of large capacity, must also continue to divert water to fill dugouts for the winter months. Total demands may easily exceed total river flows, and since the Eastern Irrigation District is the downstream project, upstream demands tend to leave it in short supply.

Normal power company operations aggravate river fluctuations, particularly in periods of low river flow. In summer, when the evenings are long, power demand and consequently the volume of water passed by the Calgary Power Company, drops after six o'clock at night and increases again about seven o'clock in the morning. More Pronounced variations in power demand take place on weekends. The Eastern Irrigation District point of diversion is not sufficiently far below the most easterly power plant to allow these flow variations to iron out and, since some of the Eastern Irrigation District canals are entirely dependent on the river for water supply, river level variations, especially in low-flow periods, are felt down the whole length of these canals. The Water Resources Branch of the Province of Alberta invoke regulatory measures prescribed for the Bow in critical periods with varying success, but

demands for water for all purposes are increasing and without remedial action in the foreseeable future, periodic shortages can only become more pronounced for all major users of the river.

Water shortages so far experienced by the Eastern Irrigation District are not large, but as the general demand for water increases and as the Eastern Irrigation District expands, larger water deficits can be expected.

Brief mention should be made of further storage possibilities. Three additional internal sites have been proposed. These are the Crawling Valley, Kitsim and Rosemary sites, which are shown on Figure 5 together with data as to capacity and acres served by each.

The Crawling Valley site would provide additional storage of about 120,000 acre-feet at a cost of $12.50 per acre-foot. The reservoir would serve the area irrigated by the northern portion of the North Branch Canal. It would also have recreational benefits. The site has been thoroughly investigated by the P.F.R.A. and is considered to be a desirable development.

The Kitsim Reservoir would store water for the areas served by the Bow Slope Canal. It became feasible as a result of the construction of the Antelope Creek Fill in 1959-60. Storage would be about 20,000

acre-feet which could be provided for about $25.00 per acre-foot, a quite reasonable cost. The site has been investigated by the P.F.R.A. Necessary road diversions have already been constructed.

The Rosemary site would provide about 6,900 acre-feet of storage and would serve some 12,000 acres of land. The cost is estimated to be $70.00 per acre-foot of storage, and for this reason is not considered economical at present. No investigation has been made by P.F.R.A.

All of these sites would serve lands now directly dependent on river flows for their water, and the construction of reservoirs at these sites would help relieve the water shortages now experienced by the District.

Additional storage might also be provided by increasing the capacity of Lake Newell. The dams and dykes on this reservoir, as originally constructed, were designed to provide for 191,000 acre-feet of live storage. However, they soon proved inadequate in both freeboard and cross-section to withstand the severe wave action at full supply level. Consequently, the District has operated the reservoir at a lower level, reducing its live storage capacity to 134,000 acre-feet. It is estimated that the additional 55,000 acre-feet could be restored to the reservoir

by strengthening the dykes and dams at a cost of about $14.25 per acre-foot. A further amount, estimated at $2.00 per acre-foot, would be required to protect the cottages at Kinbrook Island, a recreational development along the east shore of the lake. Increasing live storage in Lake Newell is an attractive possibility which warrants further investigation.

The selection of storage capacities of the potential reservoir additions cited above will require a study to determine the optimum size. The study would involve the relationship of available flows of the Bow River, the capacity of existing main canals, and possible enlargement of main canal capacities, to determine additional storage requirements. The necessity for internal storage would be alleviated in part, if not in whole, by construction of external storage reservoirs on the Bow River or its tributaries upstream of the Bassano Dam. Several external sites have been proposed. Some of these proposals would provide additional benefits in the control and use of the Bow River flows. All of the proposals require a great deal more investigation to establish their feasibility. Such investigations should include a comparative study of the merits of internal vs. external storage for the Eastern Irrigation District.

The Distribution System:

Exclusive of the 37 major irrigation structures and 91 major bridge structures discussed previously, there are 6,723 minor

structures such as checks, drops, chutes, culverts, small bridges, turnouts, etc., in the works of the Eastern Irrigation District. Most of these at one time were of timber construction which required replacement on the average of once each 10 years. Of recent years, however, much greater use is being made of metal culverts, metal delivery gates, and concrete checks and drops, which have a life expectancy in small sizes of 25 to 30 years. As there are still many wooden structures remaining, it is considered that the average life of all the smaller structures is about 15 years. The following table indicates the number of structures renewed in each of the years 1954-1963.

Year	Structures Renewed (Timber)	Structures Renewed (Concrete)	New Metal Gates Placed	Culverts	Total
1963	109	32	125	37	303
1962	167	37	159	82	445
1961	186	20	169	55	430
1960	173	15	178	48	414
1959	176	16	172	63	427
1958	180	11	200	52	443
1957	153	19	221	67	460
1956	255	9	157	54	475
1955	284	9	182	51	526
1954	302	19	137	65	523
10 yr. Total	1985	187	1700	574	4446
10 yr. Average	199	19	170	57	445

An average of 445 structures have been replaced in each of the past 10 years, a rate of renewal which, if maintained, will see all 6, 723 structures replaced within the 15 year life expectancy. From this it is concluded that the past maintenance and renewal program for the distribution structures has been adequate. This is confirmed by District Officials who have expressed the view that their present maintenance program with respect to distribution structures is satisfactory and can be maintained. In future more structures will be rebuilt in concrete which should effect a reduction in the overall maintenance costs of the distribution structures. This should, in turn, allow more emphasis to be placed on other phases of lateral maintenance such as bank strengthening, weed and willow removal, silt removal, seepage prevention, etc.

The Drainage System:

When the District took over the works of the project in 1935, a substantial network of drains was already in existence, having been constructed earlier by the C. P. R. In this, the District was indeed fortunate when compared to some of the other projects in the province in which very little consideration was given to the provision of drainage, an aspect of irrigation now considered equally important as the distribution and delivery works to the eventual success of an irrigation project.

The District has since constructed additional drains, and it can be said that virtually every farm in the District is now provided with a drainage outlet.

With the exception of scouring which is evident in some of the channels, the larger drains are in reasonably good condition. The District has constructed erosion control structures where necessary, and more of these will undoubtedly be required if scour continues. Many of the smaller drains, however, do not appear to be wholly efficient, as in many cases there is an excess growth of willows and reeds which are hindering the adequate drainage of low lying lands. Non-productive waterlogged land and sloughs may still be observed in some areas of the District. It is not known whether these remaining areas can be economically reclaimed, but it is desirable that a thorough review of the drainage system should be undertaken to ascertain the feasibility of lowering bed grades and improving gradients.

In the discussion of drains, mention should be made of several canal spillways located throughout the District which serve as a safety valve for the canals and must be made large enough to take the entire canal flow if required. They differ from drainage ditches in that their main purpose is not the removal of surplus surface water from irrigated land. There are several of these on the project, generally

located near the lower ends of main canals and laterals. Gullying of the channels is quite severe in some cases, and new control chutes and drops are required to halt the erosion.

COST ANALYSIS - DETERMINATION OF ANNUAL COST

General Discussion:

To arrive at the true annual cost of an irrigation project, two aspects of cost or cost factors must be considered. These are (1) the cost of operating, maintaining and administering the project, and (2) the cost of providing sums of money for the perpetual replacement of works. In the Eastern Irrigation District, current expenses as given in their annual reports do not make provision for the replacement of major works and are therefore only a portion of the true annual cost.

In carrying out this phase of the study a combination of methods was used. The first cost factor, that of operation and maintenance expense, was determined by a review of all the annual reports issued by the District, from which the pertinent expenditures were extracted and totalled for each year. These expenditures are summarized in Table 1 and discussed more thoroughly in the following section. Additional information is also contained in the Appendix.

The determination of the cost of providing for the perpetual replacement of the major structures and buildings, for which the District has been making no provision, was carried out by estimating the present day replacement cost of all such structures and, through the application

of straight line depreciation based on their estimated total life, arriving at the annual amount which should be set aside for their replacement. Tables 2 and 3 summarize the findings in this regard which are discussed more fully in subsequent paragraphs.

Throughout this cost analysis final figures are shown in terms of 1963 values coinciding with the last year for which current project costs are available. As the annual reports which were reviewed dated back to 1935, it became necessary to determine a factor for converting the amounts spent in earlier years to amounts which would have to be spent in 1963 to accomplish the equivalent work. Two construction cost indexes were considered for this purpose. They are the Engineering News Record Construction Cost Index and the U.S. Bureau of Reclamation Irrigation and Hydro Composite Cost Index, both of which have been plotted in graph form on Figure 6, using the years 1949-51 as a base.

It will be noted, that although both graphs follow the same general trend, they drift apart particularly in the last 10 years. This is due to the different factors upon which these indexes are based. The E.N.R. Index is based on the price of fixed volumes of construction material, such as cement, steel, and timber, together with the hourly pay of common labour as averaged throughout a number of U.S. cities,

and refers to all types of construction. The U.S.B.R. Index, on the other hand, is based on a continuing analysis of actual prices as bid by contractors for irrigation, power and related water conservation projects in the Western United States. The E.N.R. Index is considered to give a good indication of cost trends, but because it contains no provision for additional factors which enter into costs such as competition, productivity of labour, availability of material, and others, it is considered to be less reliable for the purposes of this study. The U.S.B.R. Index due to its nature does reflect these other items and, for this reason, is considered to be a more accurate indicator of such costs.

No similar index is available for costs in Western Canada, but conditions here are approximately the same as those found in the Western United States and it was decided to use the U.S.B.R. Index from 1963 back to 1940. No data was available on the U.S.B.R. Index prior to 1940, so the E.N.R. Index was used for the period 1935-40. Figure 6 also indicates the conversion factors based on these indexes, which are used throughout this study to convert earlier costs to equivalent 1963 costs.

In this study the annual costs are indicated on a cost per acre basis. In arriving at these unit cost figures, the irrigable acre-

ages used were taken from information given in the annual reports and are listed in column 8 of Table 1. They represent the total acreage in each year upon which the District levied water rates and include pumping acreage and second water rights in addition to first water rights.

Actual Operating, Maintenance and Administration Costs 1935-1963:

Table 1 summarizes for each year of the District's existence the actual costs which the District incurred in operating, maintaining, and administering the project. In the table, the total cost (Column 5) is subdivided into four main categories of expense (Columns 1 to 4) to agree more or less with the manner in which they are set out in the District's annual reports. In this regard, however, it should be noted that the figures given in the table will not always correspond exactly with the figures contained in the reports. This is because certain expenditures listed in the Statement of Revenue and Expenditure were not pertinent to the actual operation or maintenance of the project. Examples of these excluded expenditures are (1) taxes on grazing lands owned by the District, (2) provisions for hail damage, and (3) provisions for uncollectable land accounts. On the other hand, certain expenditures which relate to expenditures made in previous years and are shown in

the Revenue Surplus Statement rather than the Expenditure Statement of the District's reports, have been included in the cost compilation of this report.

The four main categories into which the annual expenditures have been subdivided are:

Operation and Maintenance (72% of the total)

This includes expenditures incurred in the actual operation and maintenance of the works of the project by the operating and maintenance personnel, and covers repairs to all structures, repairs to and periodic replacement of minor distribution structures, maintenance of all canals and drainage ditches, and other expenditures normally made from year to year for project operation and maintenance. The expenditures are further broken down, as shown in Table 1A, which together with discussion in greater detail is included in the Appendix.

Administration and General (21% of the total)

These are the costs which, for the most part, are incurred in the head office administration of the project and are support costs necessary to the proper functioning of the Dis-

trict. Certain of the costs may be connected with the function of land administration, but because of the overlapping duties of administrative personnel as well as the all inclusive nature of many of the administrative procedures, no attempt has been made to separate the costs of land administration.

These costs have been further subdivided in Table 1B which will be found, together with detailed discussion, in the Appendix.

Replacement of Capital Assets (2% of the total)

Included here are the expenditures which the District has made on the replacement of larger capital works. The figures were taken from the Statement of Reserve for the Replacement of Capital Assets which is printed as Statement C in the District's reports. Expenditures made for the replacement of any of the 37 major structures are not included.

Additions and Betterments (5% of the total)

Each of the District's annual reports given an analysis of

the value shown for irrigation structures in the capital assets portion of the balance sheet. In this analysis, monies spent each year as additions and betterments to the system, are indicated, with the larger amounts being itemized. Close examination of these expenses was undertaken. Some of the expenses should not be included in the summary of annual project cost as they were incurred in the enlargement of the project or improvement of service to the water user. The balance of the expenses are included in the summary of annual projects costs. For example, in replacing a wooden structure with a concrete structure, a portion of the cost of the new structure, representing the increased value of the structure is shown in the District's reports as a betterment. In these cases the entire cost of the replacement of the structure is included in the summary of annual project costs. The following types of expenditure are excluded from the cost tabulation:

(a) Those made for the purpose of expanding the irrigable acreage of the District. These were considered to be capital expenditures offset by increased revenue.

(b) Those made for additional internal storage of water. These were considered to be capital expenditures made for the purpose of improving the service to the water user and, in some cases, for increasing the irrigable acreage.

(c) Other major changes in the capital works of the project, which were considered to be of a special nonrecurring nature.

In most of the above cases, expenditures were large and often supported by Government grants.

The following types of expenditure are included in the summary of annual operation costs:

(a) Those which were incurred in replacing an existing small structure with an improved type of structure of higher cost and which represented the normal practice of the District.

(b) Those which were made for minor revisions or relocations of existing laterals and structures in the distribution and drainage system as these are recurring, normal type of expenditure.

A breakdown of the expenditures for additions and better-

ments is shown in Table 1C, which, together with detailed descriptions of both the excluded and included items, will be found in the Appendix.

The costs incurred in the four categories as discussed above are totalled for each year, as shown in Column 5 of the table. To these totals the conversion factor, previously explained and shown in Column 6, has been applied to give the total expense in terms of the 1963 dollar value as shown in Column 7. This figure has been divided by the irrigable acreage for each year to give the unit cost per acre shown in Column 9. Finally the average cost per acre for these purposes for the entire period is shown to have been $3.30, while that for the last ten years has been $3.11 expressed in terms of the 1963 dollar.

To the figures in Table 1, an allowance for canal maintenance, which has not been carried out by the District, is added. This allowance is required to provide for the continued operation of the main canals as mentioned previously in this report.

In order to arrive at an estimate of the work required to restore the main canals into satisfactory condition, portions of these canals were inspected in the field. The volume of earthwork required in the inspected portions was estimated and by direct proportion of the total canal mileage inspected, the total earthwork was determined. It

should be emphasized that the estimate is based on visual inspection only and as a result, must be considered to be very approximate. The earthwork estimate includes both bank strengthening and silt removal volumes.

All canals carrying 50 c. f. s. or more were considered to be main canals. These include the North Branch, East Branch, Bow Slope, Rolling Hills, Springhill and Bantry canals.

The following table summarizes the results of this inspection.

Main Canal	Total Length Over 50 c. f. s. (miles)	Length Inspected (miles)	Earthwork Req'd. in Inspected Length (cu. yds.)	Total Earthwork Required (cu. yds.)	Cost at 50¢ per cubic yards
North Branch	64	38	25,000	40,000	$20,000
East Branch & Bow Slope	78	47	60,000	100,000	50,000
Spring Hill	70	24	35,000	100,000	50,000
Bantry System	95	26	25,000	90,000	45,000
Rolling Hills	35	15	30,000	70,000	35,000
TOTAL	342	150	175,000	400,000	$200,000

Using this total figure of $200,000 as representing the money now required to rehabilitate the canals, it is concluded that had the District expended an extra $4,000 per year over its 50 years of operation, the canals would not now require rehabilitation. Therefore, this amount is added to the actual operation and maintenance figures. It should not be necessary to set up an allowance for future rehabilitation of canals as must be done in the case of structure replacement, because this type of work can and should be carried on from year to year using normal revenue funds.

Provision for Replacement of Buildings and Major Structures:

This portion of the analysis is concerned with the annual amounts which should be set aside to recover the cost of buildings and major structures and bridges which are of a nonpermanent nature and must eventually be completely replaced. To date the Eastern Irrigation District has not been providing for this in their accounting. The buildings, with one exception, are not being depreciated, nor are any annual deposits being made to a fund which might be used for the replacement of structures. (The District does possess "reserve" assets in the form of bonds and debentures to the value of approximately $1,000,000 which can be considered as an emergency replacement fund. This fund, however, has remained substantially unchanged for many years, the interest

earned by it being channeled into current revenue. A portion of these assets are also used as hypothecation for loans made from time to time to the District for operating purposes.)

In the following discussion major structures and bridges are considered separately from buildings.

1. Major Structures and Bridges - Table 2:

In an earlier part of the report it is stated that the replacement of all the minor structures in the distribution system is being adequately taken care of by the present maintenance program of the District. In this portion of the analysis an allowance is to be determined for the replacement of the 37 major irrigation structures and the 91 major bridge structures which have been referred to in the descriptive section of this report.

The 37 major structures, ranging in size from the Bassano Dam to the Rock Lake turnouts are listed in Table 2, which also indicates P. F. R. A. estimates for replacement cost, remaining life of the existing structures and total life for depreciation purposes. Replacement costs are estimated on the basis of element designs and are approximate only. Actual costs may vary by 25%.

In the case of the Bassano Dam it is estimated that a major expenditure of $1,800,000 for repairs now will prolong the life of the structure another 25 years at which time complete renewal will be required at a cost of $6,000,000. Both of these figures are included in the table. It will be noted that the value of the Brooks Aqueduct is shown at $1,000,000 rather than $1,300,000 as shown on Figure 3. This is due to the fact that $300,000 is the cost of the earthfill portion of a new aquaduct for which no replacement provision is required. The estimated replacement cost of major bridge structures is segregated into amounts payable by each of the responsible bridge authorities. A further breakdown of these figures covering both bridges and culverts is included in the Appendix. No allowance is made for the 28 major bridges which, as has been suggested earlier, might be abandoned.

Table 2 indicates that the total annual amount which must be set aside to provide for recovery of the replacement cost, using the straight line method of depreciation, is $202,130.

2. Buildings and Dwellings - Table 3:

In order to arrive at the annual cost for replacement of buildings and dwellings, it is first necessary to determine the present

day replacement cost of these buildings. They were carried at a value of $262,000 on the books of the District at the end of 1963, but it was obvious that the present cost of replacing the buildings would greatly exceed this amount. Accordingly, the present costs are determined by taking the actual capital amounts spent for new buildings and additions to old buildings during the years 1935-63 and escalating these amounts to present day costs by applying the conversion factor of Figure 6. To this cost is added the depreciated value of the buildings at 1935, escalated to the 1963 base. The reason for using the depreciated value in 1935 is because some of the capital expenditures made subsequent to 1935 were actually incurred for the purposes of rebuilding, modernizing, or moving to new locations, the original buildings. If the first cost of the buildings which existed prior to 1935 is used, duplication might result in some cases and it is more realistic, therefore, to escalate the depreciated value alone.

Table 3 summarizes the findings and indicates the total present day cost of the buildings and dwellings to be $576,000, for which the annual depreciation is $11,500.

Summary of Annual Cost:

The two main cost components, as discussed and described above, are brought together as shown in Table 4 and totalled to give the annual cost which is shown to be $852, 300 or $4. 43 per irrigable acre, consisting of $3. 32 per acre for project operation and $1. 11 per acre for replacement of major structures and buildings.

The figures given in Table 4 pertain to the cost of the project as it now exists. No attempt is made to project the annual cost which might apply as a result of the construction of further reservoirs and other works and/or an increase in the irrigable area. Whether additional capital investment increases the unit cost per acre depends on the amount of additional acreage developed as a result of the further investment. With respect to reservoirs, these consist largely of earthwork, having infinite life and very low maintenance costs, so it is reasonable to expect that the construction of these will tend to decrease per acre costs. This would particularly apply to the Crawling Valley Reservoir as its construction would eliminate two large existing structures subject to periodic renewal.

ACKNOWLEDGEMENTS

We wish to express our appreciation for the valuable assistance of Mr. R. T. White, General Manager of the E. I. D., and his staff in providing information from the District records pertinent to certain components of this study.

APPENDICES

APPENDIX A

OPERATION AND MAINTENANCE EXPENSES - TABLE 1A:

This table breaks down the operation and maintenance expenditures, as shown in Column 1 of Table 1, into seven categories. All figures include expenditures recovered through the Winter Works Incentive Program. A brief description of each category follows, indicating (in brackets) the portion of the Eastern Irrigation District annual reports from which the figures were taken e. g. , (Schedule 1).

Column (1) Salaries and Wages:

Included herein are the salaries of the operating staff - watermasters, ditchriders, patromen, gatemen - and the salaries and wages of the maintenance staff - foremen, labourers, carpenters, etc. (Schedule 1).

Column (2) Heavy Equipment:

This includes:

(a) Supplies, repairs, transportation expense, operators' wages and other maintenance charges for earthmoving machinery. Revenue derived from work performed for others is deducted. (Schedule 1).

(b) Provision for depreciation of equipment (Statement of Revenue and Expenditure).

(c) Profit from the sale of equipment is deducted, as this represents amounts by which equipment has been over-depreciated at the time of its disposal. (Statement of Revenue Surplus).

Column (3) - Materials and Supplies:

This represents the cost of all materials required for the repair and maintenance of district structures, including the replacement of small distribution structures. (Schedule 1).

Column (4) - Transportation:

This includes the cost of providing and operating vehicles required by the maintenance and operating staff. (Schedule 1).

Column (5) - Irrigation Pumps:

This covers the costs of operating and maintaining various pumping installations located throughout the District. (Schedule 1).

Column (6) - Premises:

These are the expenses incurred in maintaining dwellings

for operating staff and bunkhouses for maintenance crews. (Schedule 1). Also included are costs shown as Dwelling Expense (Statement of Revenue and Expenditure).

Column (7) - Other:

Included here are all the remaining expenses contained in the District's Schedules of Maintenance and Operation. They are mostly of a minor nature, such as weed and willow control, tools and light equipment, telephone costs, etc. (Schedule 1).

APPENDIX B

ADMINISTRATION AND GENERAL EXPENSES - TABLE 1B:

This table subdivides the administration and general costs shown in Column 2 of Table 1, into seven categories which are discribed more fully in the following paragraphs. The sources of the figures, which again is from the Eastern Irrigation District Annual Reports, is shown in brackets.

Column (1) - Salaries and Wages:

Included here are the salaries of personnel engaged in management, engineering, land administration, accounting and other head office work. (Schedule 2).

Column (2) - Pensions:

This represents the amounts set aside each year by the District as its contribution towards the pensions of permanent employees (Schedule 2) which, in turn, has been adjusted by those amounts shown under the heading "Recovery of Prior Years Pension Plan Contributions". (Statement of Revenue Surplus).

Column (3) - Interest and Bank Charges:

Represents, for the most part, interest charges on loans required for operating the project. (Schedule 2).

Column (4) - Taxes and Maintenance of Buildings:

This covers the costs of maintaining headquarters buildings and grounds (Schedule 2). Also included are the taxes paid on land within town boundaries which are occupied by District buildings. No taxes are paid on most of the dwellings occupied by the operating personnel, as the Irrigation Districts Act exempts such property from taxation if it lies within the boundaries of municipal districts or counties. The greater portion of the taxes paid by the District are those assessed on grazing lands owned by the District and are not included in this figure. (Taxes taken from Statement of Revenue & Expenditure and adjusted in accordance with figures supplied by Eastern Irrigation District personnel).

Column (5) - Insurance:

Includes the following types of insurance - fire and other hazards re buildings, public liability, automobile and group life. (Schedule 2).

Column (6) - Travel:

This covers the cost of vehicles operated by head office staff and all other travel expenses. (Schedule 2).

Column (7) - Other:

Included herein are all the remaining expenses listed in the schedule of Administration and General Expense of the Eastern Irrigation District reports, most of which are of a minor nature, such as Workmen's Compensation Board assessment, muskrat and beaver bounty, stationery and printing, Board of Trustees' expense, audit fees, postage, telephone and telegraph, legal expense, ratepayers' expense and annual reports, etc. (Schedule 2). Also included are amounts paid in crop and flood damage. (Statement of Revenue and Expenditure).

EXPENDITURES FOR ADDITIONS & BETTERMENTS TO PROJECT - TABLE 1C:

As explained in the body of this report, certain of the expenditures, listed in the Eastern Irrigation District annual reports, as additions and betterments to the project, are included in Talbe 1, Summary of Annual Expenses for Project Operation. Table 1C shows how these expenditures are divided for either inclusion in or exclusion from Table 1. Columns 1 to 4 show the portion of expenditure which is excluded, while Columns 5 to 7 show the portion included. Column 8 indicates the total expenditure for these purposes.

Column (1) - New Development:

This indicates amounts expended on projects to increase the irrigable acreage of the District. The projects, together with the total amounts expended to date, are as follows:

	By E.I.D.	By Gov't. of Canada	Total
Rolling Hills Project	$244,528	$45,650	$290,178
Bantry "A" (Scott) Project	31,505		31,505
Bantry Pump	60,704		60,704
Other Pump Projects	37,559		37,559
Other Extensions	6,456		6,456
TOTALS	$380,752	$45,650	$426,402

Column (2) - Improvements to Service:

In this column are listed expenditures made to increase internal storage on the project and for other major changes in the physical works. The projects, together with the total amounts expended to date, are as follows:

	By E. I. D.	By Gov'ts.	Total
One Tree Creek Res.	$ 16,261	$ 14,990	$ 31,251
Cowoki Res.	47,355	7,500	54,855
"J" Reservoir	24,935		24,935
Rock Lake Res.	15,015	112,800	127,815
Antelope Creek Fill	175,379(a)	182,528	357,907(a)
TOTALS	$278,945	$317,818	$596,763

Note (a)

E. I. D. contributed an additional $160,253 towards the Antelope Creek Fill which is shown in their annual reports under replaced capital assets, as the Antelope Creek Syphon was abandoned after the fill was completed.

Column (3) - Major Structures:

These are capital expenditures made by the District on some of the major structures, either by nature of improvement, extension or

renewal. They are excluded from the tabulation of current costs (Table 1) as the major structures are considered as a separate entity in the report and inclusion would have resulted in duplication. Structures upon which the District incurred these expenditures are as follows:

Rock Lake Dam Outlets	$ 19,654
Antelope Creek Fill Structures	110,107
Bassano Dam	13,274
Brooks Aqueduct	6,697
East Branch Canal Headgates	4,742
Nigger John Spillway	7,269
One Tree Res. Spillway	3,180
Springhill Canal Chute	20,512
East Branch Canal Check at Dist. 10	7,344
Rolling Hills Canal Check	4,091
Springhill Canal Checks	26,608
TOTAL	$223,478

Column (4) - Total:

This is the total of Columns 1 to 3 and represents the portion of the expenditures for Additions and Betterments which are not considered in the Table 1 Summary.

Column (5) - Other Itemized Betterments:

These are the expenditures which the District makes from year to year in upgrading their works, details of which are listed in the annual reports and which do not fall into the excluded categories listed above. The following summarizes these amounts by type of work:

Canal cutoffs, (Cassils, Tilley, Bow Slope, Antelope Creek)	$ 47,071
Spillways and Drains (Sauki, Bow Slope, Lathom Flume, Rolling Hills Drain Pump, Bow Slope Chute, Mackenzie Spillway, #2 Spillway)	27,498
Metal Deliveries, Culverts, etc.	17,370
Springhill System (checks, turnouts, etc.)	9,320
North Branch Canal Distribution System	5,149
Bantry Canal System (South Br. Hdgtes., North Branch Chute "R", West Branch Turnout & Chute, West Branch "H" Chute)	23,981
Rolling Hills Checks	4,416
Miscellaneous	4,131
Telephone Extension	11,627
TOTAL	$150,563

Column (6) - Miscellaneous Betterments:

In this column are additional expenditures made in improving the works and which are mostly for minor structures. They are listed merely as "Miscellaneous Betterments" in the District's reports.

Column (7) - Total:

This is the total of Columns 5 and 6 and represents the portion of expenditures for additions and betterments which are included in Table 1.

Column (8) - Total:

This is the total of expenditures as reported in the District's annual reports for additions and betterments to the physical works.

APPENDIX D

COST BREAKDOWN OF MAJOR BRIDGES AND CULVERTS:

1. Major Bridge Summary:

	Responsible Authority			
Condition	Province	County	E. I. D.	Total
Good - will last 15 to 30 years or more				
Number	5	14	3	22
Length - Ft.	492	724	140	1,356
Req'd. Average Width-Ft.	40	30	24	-
Area - Sq. Ft.	19,680	21,720	3,360	44,760
Replacement Value (at approx. $7/sq. ft.)	$138,000	$152,000	$25,000	$315,000
Fair - will last for 10 to 15 years				
Number		5	13	18
Length		382	1,038	1,420
Req'd Average Width		30	24	-
Area - Sq. Ft.		11,460	24,912	36,372
Replacement Value		$80,000	$175,000	$255,000
Poor - to be replaced in next 5 years				
Number		4	4	8
Length		204	216	420
Req'd Average Width		30	24	-
Area - Sq. Ft.		6,120	5,184	11,304
Replacement Value		$43,000	$37,000	$80,000

Very Poor - immediate replacement required				
Number		1	4	5
Length		48	268	316
Req'd Average Width		30	24	-
Area - Sq. Ft.		1,440	6,432	7,872
Replacement Value		$10,000	$45,000	$55,000
TOTAL REPLACEMENT VALUE	$138,000	$285,000	$282,000	$705,000

2. Major Culvert Summary:

On Provincial Highways		Replacement Value
432' of 48" diam.	@ $15.00/ft.	$ 6,480
170' of 66" diam.	@ 28.00/ft.	4,760
248' of 72" diam.	@ 32.00/ft.	7,936
		$19,176
		Say $20,000

On County Roads		
60' of 54" diam.	@ $20.00/ft.	$ 1,200
110' of 76" diam.	@ 35.00/ft.	3,850
44' of 65"x40" arch	@ 25.00/ft.	1,100
		$ 6,150
		Say $ 6,000

On Local Roads - E.I.D. Responsibility		
60' of 54" diam.	$ $20.00/ft.	$ 1,200
132' of 48" diam.	15.00/ft.	1,980
		$ 3,180
		Say $ 3,000
	TOTAL VALUE	$29,000

APPENDIX E

ESTIMATED COST OF ADDITIONAL WATER STORAGE:

There are four proposals for increasing storage in the Eastern Irrigation District. The table below shows the storage that could be provided, together with the estimated cost of each scheme. The figures for Lake Newell are those required to raise the level of the reservoir by 3.5 feet and includes an estimated $110,000 for protection to Kinbrook Island. The estimates for Crawling Valley and Kitsim Reservoirs are based on actual field surveys and site investigations by P.F.R.A. and should be fairly accurate. No field investigation has been carried out for the Lake Newell and Rosemary proposals, and the figures in these cases are very rough estimates. The costs indicated are for the maximum size of potential storage additions. The selection of the optimum size of storage reservoirs requires a study of existing main canal capacities and possible enlargement of main canals. The costs of canal enlargements would be determined from this study. The cost of canal enlargements, if required, may be offset to some degree by a reduction in reservoir costs indicated. The costs of alternative external storage reservoirs, on the Bow River or its tributaries, which require further studies, are not included. The total of the costs shown below indicates only the order of magnitude of expenditure re-

quired to provide additional storage capacity.

Reservoirs	Capacity Acre-Feet	Estimated Cost	Cost/Acre-Foot
Lake Newell	55,000	$ 570,000	$16.28
Crawling Valley	120,000	1,500,000	12.50
Kitsim	20,000	473,000	25.00
Rosemary	4,500	325,000	72.00
	199,500	$2,868,000	

APPENDIX F

SUGGESTED PRIORITIES FOR REHABILITATION PROGRAM:

This report points out the need for early renewal of many of the existing major structures. A program of rehabilitation could be spread over a period of years, giving priority to those structures most urgently in need of attention. To illustrate, a schedule such as outlined herein might be set up as a guide. It is separated into five phases or stages, each of which may be conveniently completed in one year. The schedule is flexible and may be altered if circumstances dictate.

The estimated cost of the structure rehabilitation, as outlined herein, is $4,727,000.

STAGE 1

Structure		Estimated Cost
Bassano Dam - 50% repair		$ 900,000
Brooks Aqueduct - 50%		650,000
Antelope Creek Spillway		90,000
North Branch Drop		250,000
Bridges		30,000
Undesignated Structures		50,000
	Total, Stage 1	$1,970,000

STAGE 2

Structure		Estimated Cost
Bassano Dam - 50% repair		$ 900,000
Brooks Aqueduct - 50%		650,000
Springhill Canal Headgates		53,000
Lake Newell Inlet		52,000
Bridges		30,000
Undesignated Structures		50,000
	Total, Stage 2	$1,735,000

STAGE 3

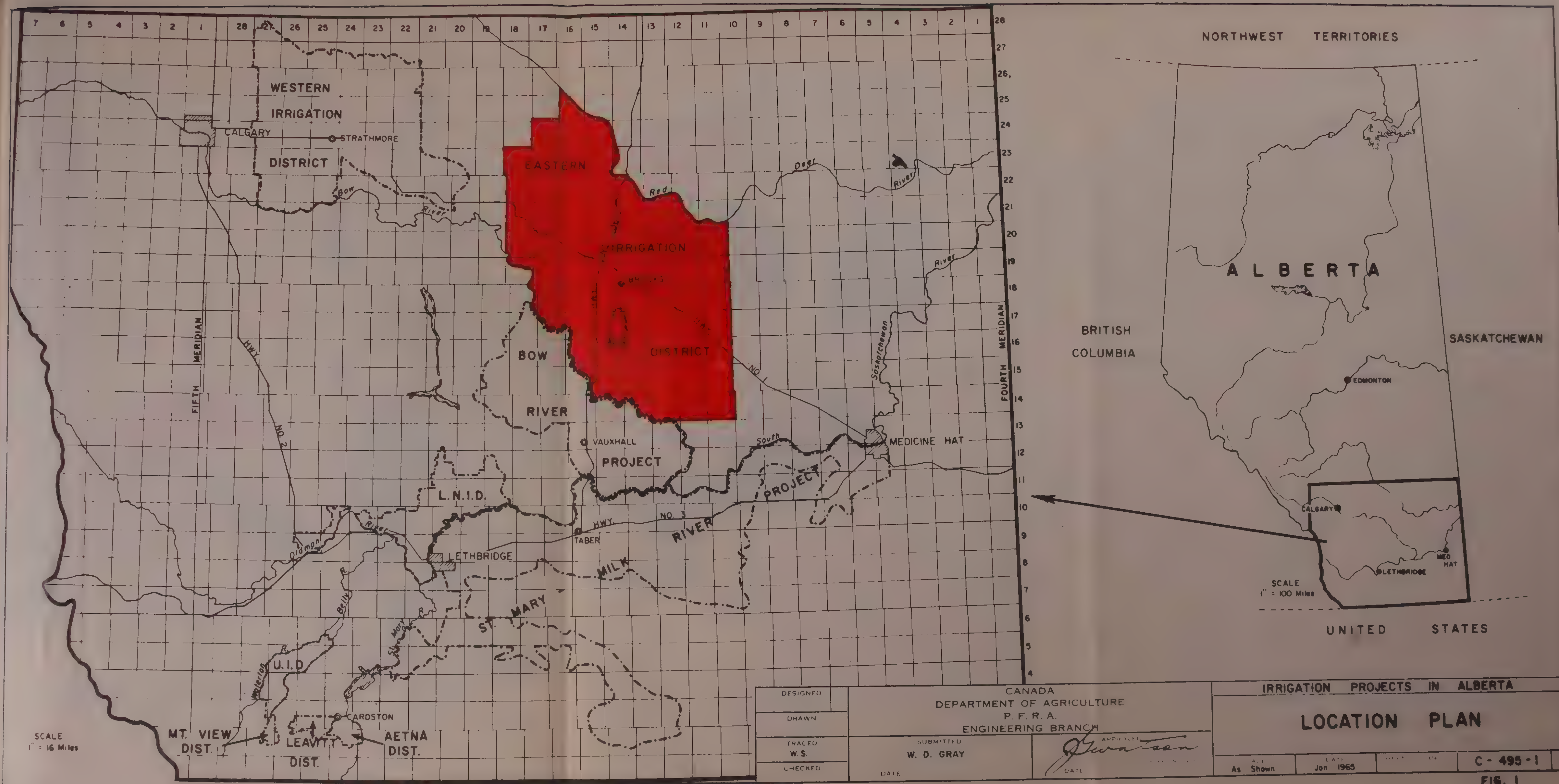
Bantry Canal Headgates		$ 125,000
Rolling Hills Res. Inlet		90,000
Cassils Canal Check		37,000
Bridges		25,000
Undesignated Structures		30,000
	Total, Stage 3	$ 307,000

STAGE 4

Structure	Estimated Cost
Bassano Check	$ 35,000
North Branch Headgates	41,000
East Branch Headgates	63,000
Spring Hill (Secondary A) Check	38,000
Bridges	25,000
Undesignated Structures	30,000
Total, Stage 4	$ 232,000

STAGE 5

Nigger John Syphon	$ 50,000
Nigger John Spillway	36,000
Lathom Flume	350,000
Bridges	25,000
Undesignated Structures	22,000
Total, Stage 5	$ 483,000



DESIGNED	
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CHECKED	

CANADA
DEPARTMENT OF AGRICULTURE
P. F. R. A.
ENGINEERING BRANCH

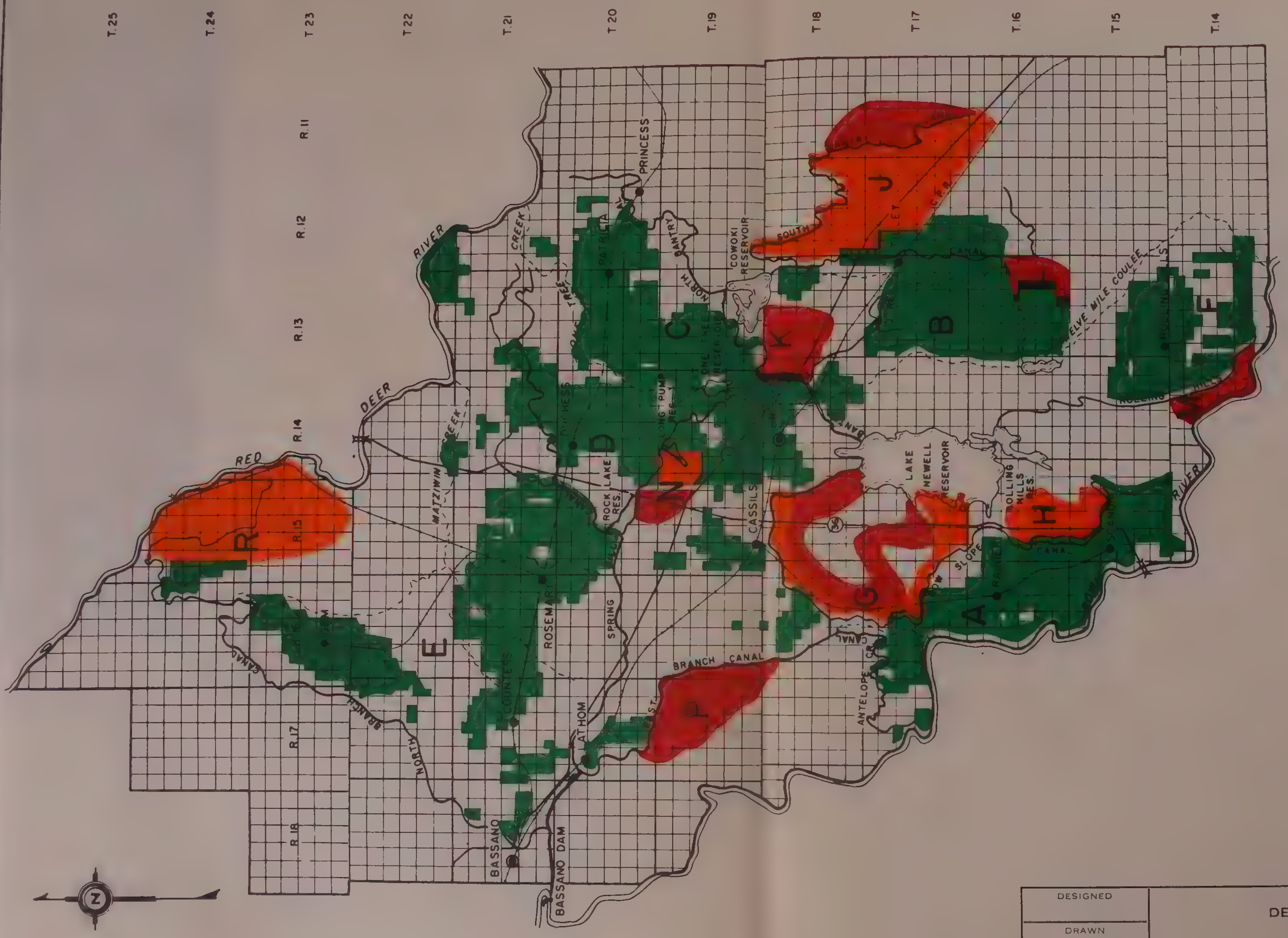
SUBMITTED W. D. GRAY
DATE
APPROVED G Watson
DATE

IRRIGATION PROJECTS IN ALBERTA

LOCATION PLAN

SCALE	DATE	SHEET OF	
As Shown	Jan 1965		C - 495 - 1

FIG. 1



PRESENTLY IRRIGATED AREAS 🟩

	Districts	Irrigable Area
A.	Antelope Creek, Bow Slope, Kitsim, Bow City and Scandia	27,962 acres
B.	Tilley, Elizabeth, Bantry, Aqueduct, Bantry Pumps	38,092 acres
C.	Brooks, Cowoki, Millicent, Patricia	30,641 acres
D.	Long Pump, Duchess, Welsh, Imperial, McKenzie & Cockerill	34,691 acres
E.	Bassano, Countess, Pitau, Gem, Rosemary	36,288 acres
F.	Rolling Hills, Robsart, Twelve Mile	24,650 acres
	TOTAL	192,324 acres

POSSIBLE EXTENSIONS TO IRRIGABLE AREAS

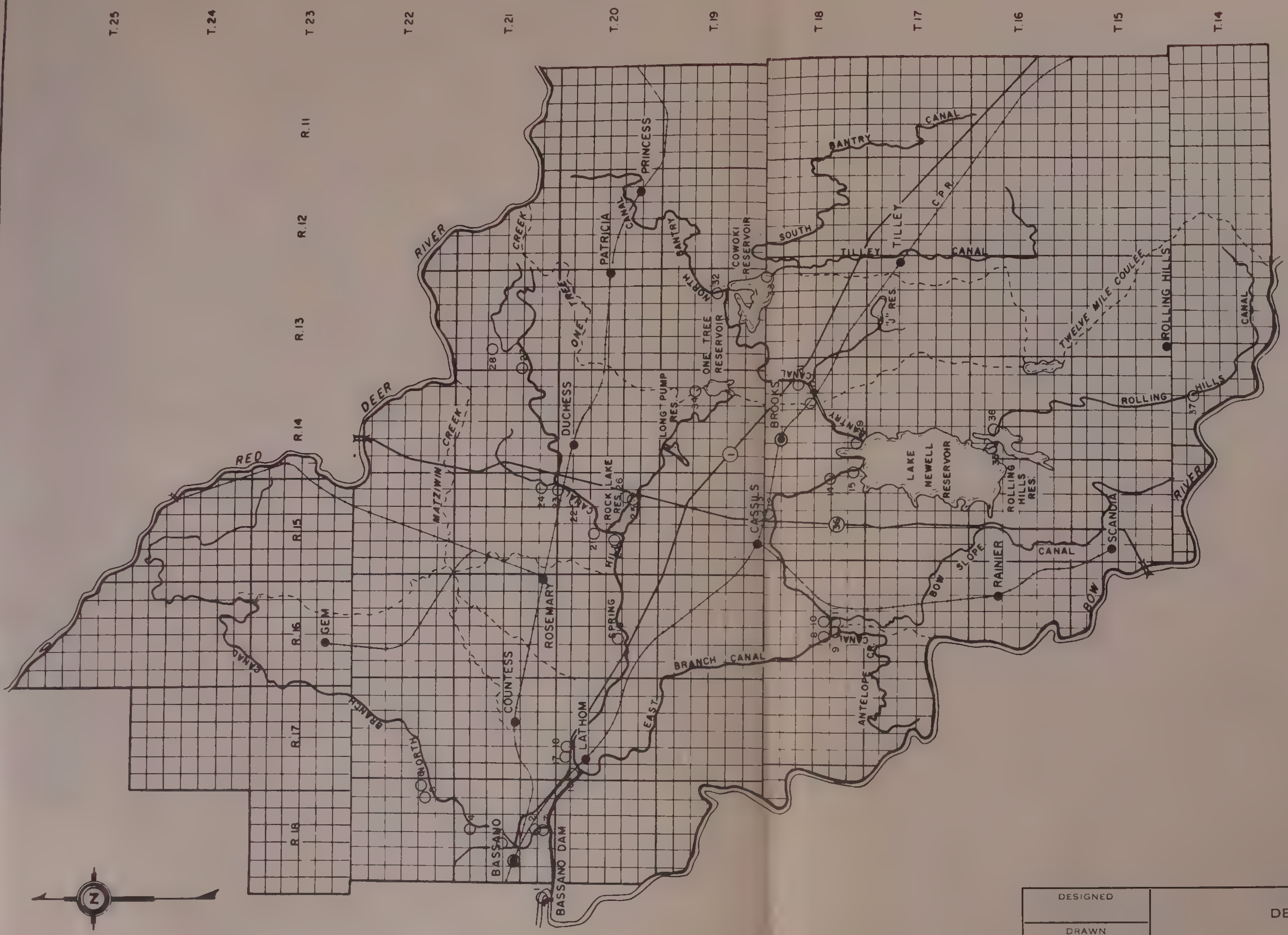
	Location	By Gravity 🟧	By 15' Pump Lift 🟥
G.	Kitsim	9,000 acres	13,000 acres
H.	Kitsim Extension	5,000 acres	
J.	South Bantry	15,000 acres	5,000 acres
K.	Bantry		5,000 acres
L.	Bantry Pump		1,000 acres
M.	Rolling Hills		1,000 acres
N.	Spring Hill	2,000 acres	2,000 acres
P.	East Branch		8,000 acres
R.	North Branch	10,000 acres	
	TOTALS	41,000 acres	35,000 acres

DESIGNED	CANADA DEPARTMENT OF AGRICULTURE P. F. R. A. ENGINEERING BRANCH	EASTERN IRRIGATION DISTRICT
DRAWN		LOCATION OF IRRIGABLE AREAS
TRACED	SUBMITTED W.D. GRAY	APPROVED CHIEF ENGINEER
CHECKED	DATE	DATE

SCALE 1" = 6 MILES
DATE JAN. 1965
SHEET OF
C-495-2

FIG. 2

FIG. 3



	Structure Description	Age In 1963	Estimated Remaining Life (years)	Estimated Replacement Cost (dollars)
1.	Bassano Dam	50	25	6,000,000
	NORTH BRANCH CANAL			
2.	Headgates	51	4-8	41,000
3.	Bassano Check . R	51	4-8	35,000
4.	Secondary A Check	51	4-8	33,000
5.	Stepped Drop R	51	2-5	34,000
6.	Crawling Valley Flume	35	5-10	250,000
	EAST BRANCH CANAL			
7.	Headgates	51	4-8	63,000
8.	Antelope Creek Canal Check	3	45-50	39,000
9.	Antelope Creek Spillway . 1972	51	2-5	90,000
10.	Kitsim Canal Check	3	45-50	45,000
11.	Kitsim Canal Headgates	3	45-50	35,000
12.	Cassils Canal Check	50	2-5	37,000
13.	Cassils Canal Syphon	6	35-40	75,000
14.	Distributary 10 Check	7	40-45	35,000
15.	Lake Newell Inlet - u	51	2-5	52,000
	SPRINGHILL CANAL			
16.	Headgates R	29	2-5	53,000
17.	Lathom Flume 1972	36	4-8	350,000
18.	Secondary A Check R	41	4-8	38,000
19.	Chute	7	40-50	50,000
20.	Rock Lake (Sec. C) Check	1	45-50	35,000
21.	Dist. 13 Check	New	45-50	35,000
22.	Dist. 14 Check	New	45-50	35,000
23.	Dist. 16 Check	12	40-45	33,000
24.	Secondary F Check	41	5-10	35,000
25.	Rock Lake Turnout — Secondary C	6	45-50	20,000
26.	Rock Lake Turnout — Secondary D	6	45-50	20,000
27.	Nigger John Syphon R - 70-71	31	4-8	50,000
28.	Nigger John Dam & Spillway	8	4-8	36,000
	BANTRY CANAL			
29.	Headgates R.	51	4-8	125,000
30.	Brooks Aqueduct	50	2-5	1,300,000
31.	West Bantry & North Bantry Split	50	5-10	47,000
32.	North Bantry Check to Cowoki Res.	7	40-50	39,000
33.	Cowoki Res. Outlet to Tilley Canal	8	25-35	33,000
34.	One Tree Res. Spillway R .	26	2-5	33,000
	ROLLING HILLS CANAL			
35.	Rolling Hills Res. Inlet — u	51	4-8	90,000
36.	Rolling Hills Res. Outlet	6	25-35	41,000
37.	Secondary A Check	6	45-50	27,000

DESIGNED
DRAWN
TRACED
CHECKED

CANADA
DEPARTMENT OF AGRICULTURE
P. F. R. A.
ENGINEERING BRANCH

SUBMITTED W.D. GRAY
DATE

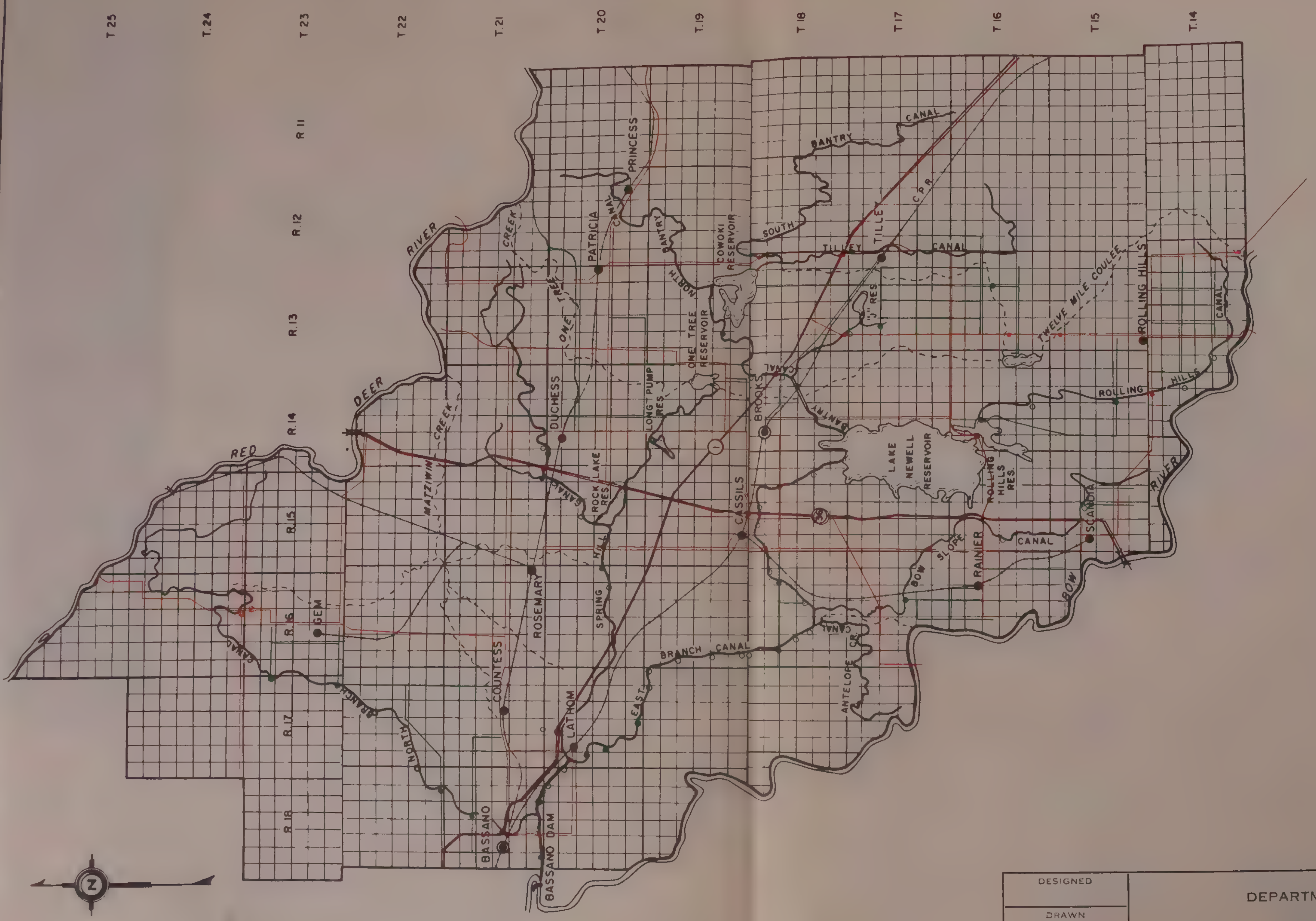
APPROVED
CHIEF ENGINEER
DATE

EASTERN IRRIGATION DISTRICT

LOCATION PLAN
MAJOR CANAL STRUCTURES

SCALE 1" = 6 MILES
DATE JAN. 1965
SHEET OF
C-495-3

FIG. 3



LEGEND AND DATA

ROADS

Red — Provincial Highways
Orange — District or County Highways
Green — Local Roads

MAJOR BRIDGE STRUCTURES

(Those over natural drainage courses not included)

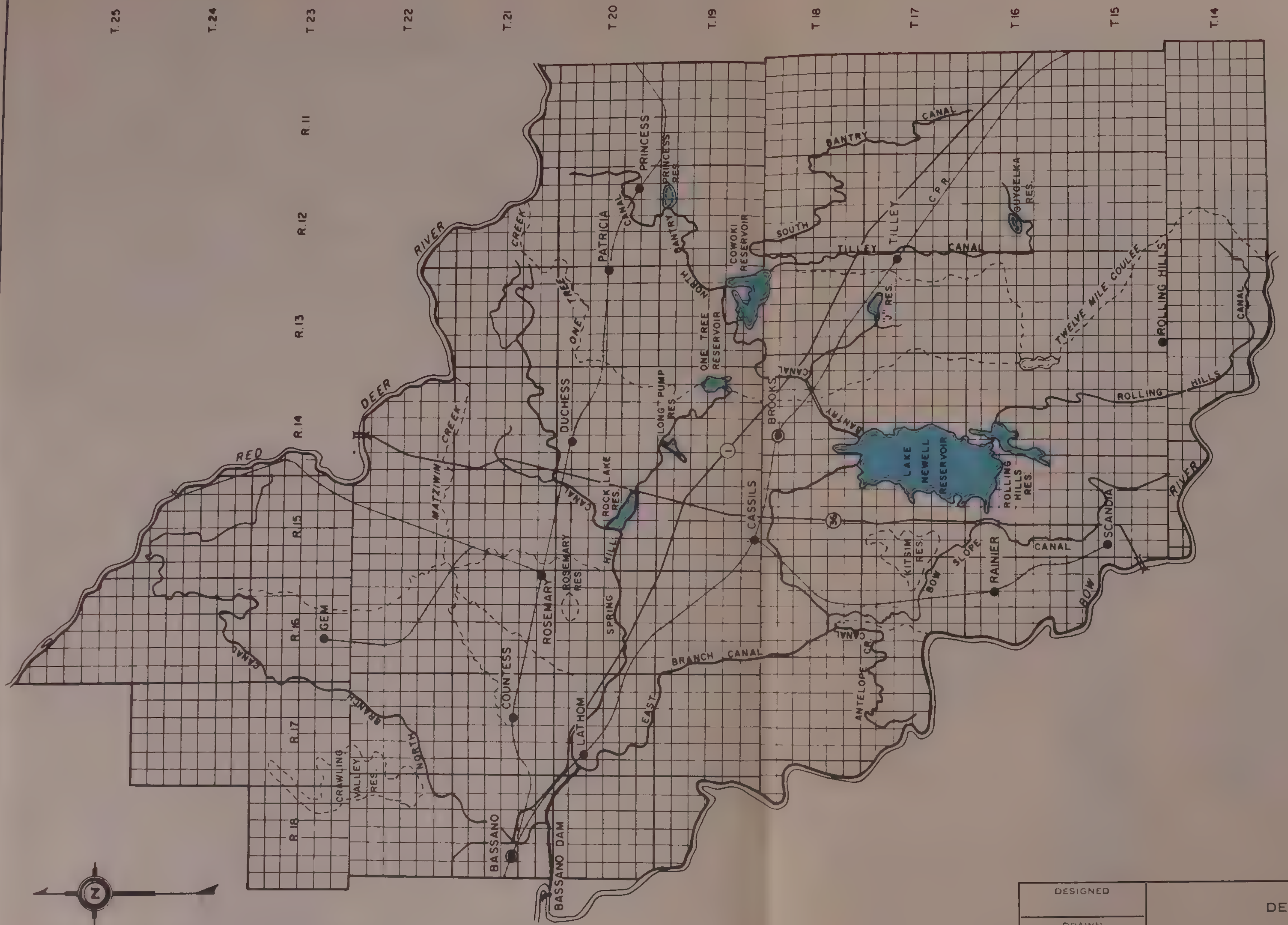
Colour	Responsible Authority	No. of Bridges (Span 20')	No. of Culverts (Diam. 60")	Total
Red	Province	5	4	9
Orange	County	24	3	27
Green	E.I.D.	52	3	55
	TOTAL	81	10	91

○ Indicates location of 28 bridges which might be abandoned.

DESIGNED	CANADA DEPARTMENT OF AGRICULTURE P. F. R. A. ENGINEERING BRANCH		EASTERN IRRIGATION DISTRICT		
DRAWN			LOCATIONS OF ROADS & BRIDGES		
TRACED	SUBMITTED W.D. GRAY	APPROVED CHIEF ENGINEER			
CHECKED	DATE	DATE	SCALE 1" = 6 MILES	DATE JAN. 1965	SHEET OF

C-495-4

FIG. 4



EXISTING RESERVOIRS

Reservoir	Total Capacity (Acre-feet)	Live Storage (Acre-feet)	Irrigable Area Served (Acres)
Lake Newell	204,000	134,000	80,000
Cowoki	15,000	13,200	10,900
Rolling Hills	14,155	8,130	25,000
Rock Lake	6,000	4,800	10,000
One Tree	1,982	1,789	6,900
Douglas ("J")	1,364	1,364	2,860
Princess		negligible	nil
Guygelka	unknown	500	3,300
Long Pump	unknown	unknown	1,560

NOTE:—Acreages shown as served by Cowoki Lake, Rolling Hills, Douglas and Guygelka storages are included in the acreage shown as being served by Lake Newell.

POSSIBLE ADDITIONAL RESERVOIRS

Name	Capacity (Acre-feet)	Irrigable Area Served (Acres)
Crawling Valley	120,000	19,000 present 10,000 new
Kitsim	20,000	22,000 present 25,000 new
Rosemary	6,900	12,000

NOTE:—It is also possible to increase the capacity of Lake Newell by 55,000 acre-feet.

DESIGNED
DRAWN
TRACED
CHECKED

CANADA
DEPARTMENT OF AGRICULTURE
P. F. R. A.
ENGINEERING BRANCH

SUBMITTED
W.D. GRAY
DATE

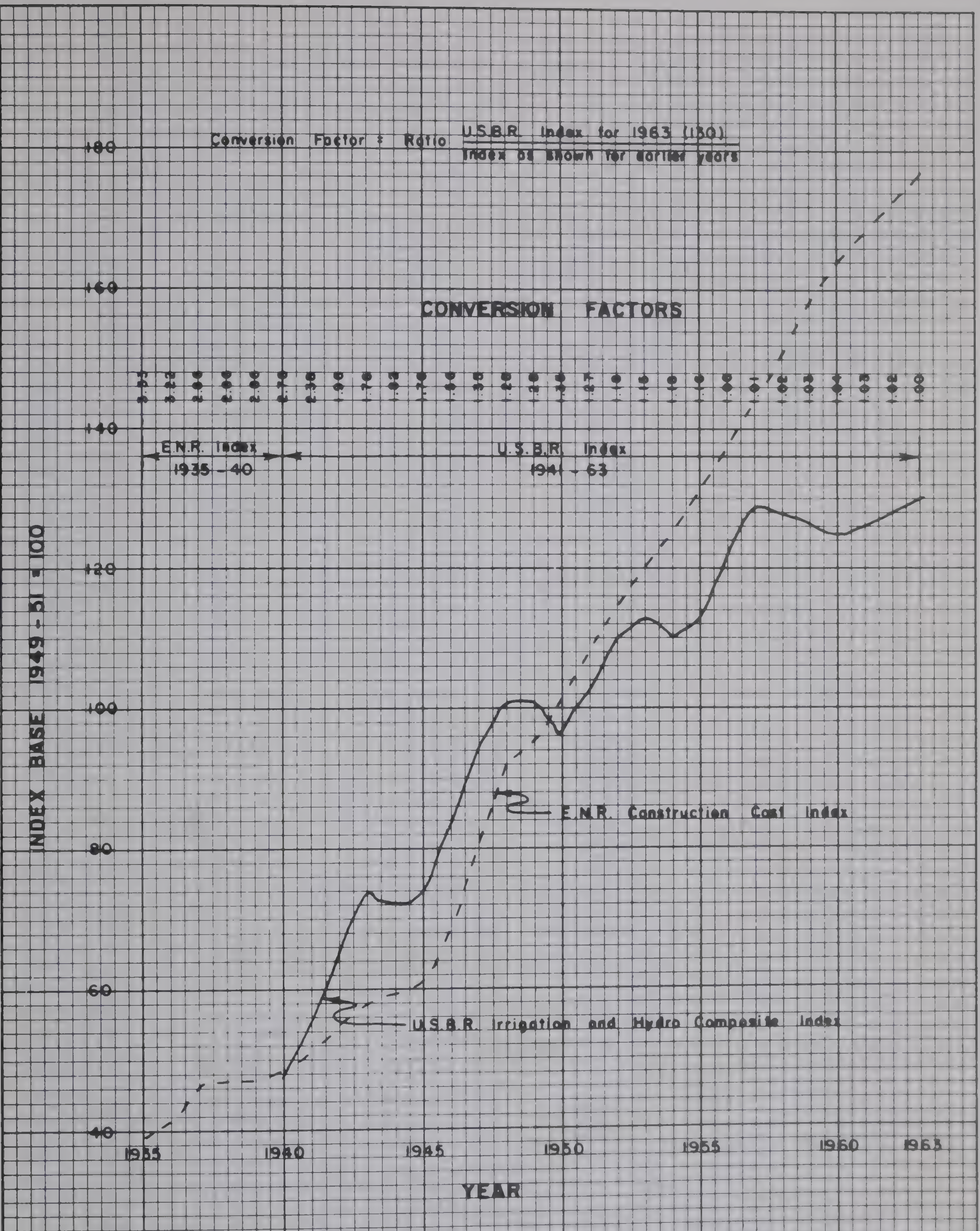
APPROVED
CHIEF ENGINEER
DATE

EASTERN IRRIGATION DISTRICT

LOCATION PLAN SHOWING
EXISTING & POSSIBLE RESERVOIRS

SCALE 1" = 6 MILES
DATE JAN. 1965
SHEET OF
C-495-5

FIG. 5



CONSTRUCTION COST INDEXES

FIG. 6

EASTERN IRRIGATION DISTRICT

TABLE 1

SUMMARY OF PAST EXPENSES FOR PROJECT OPERATION 1935-1963

Year	(1) Operation & Maintenance (See Table 1A)	(2) Administration and General (See Table 1B)	(3) Replacement of Capital Assets	(4) Included Additions & Betterments (See Table 1C)	(5) Total	(6) Conversion Factor to 1963 Base	(7) Total Expenses 1963 Base	(8) Irrigable Acreage	(9) Cost/Acre
1935	$ 95,581	$ 30,928	$	$	$ 126,509	3.33	$ 421,000	112,925	$ 3.73
1936	138,114	44,916			183,030	3.22	589,000	125,279	4.70
1937	152,237	46,500		600	199,337	2.86	570,000	139,645	4.08
1938	122,573	46,871		5,149	174,593	2.86	499,000	148,928	3.35
1939	186,413	47,931		5,532	239,876	2.86	686,000	156,688	4.38
1940	176,332	63,099	6,846	2,885	249,162	2.78	693,000	153,462	4.52
1941	199,420	59,191	8,592	1,018	268,221	2.38	638,000	157,357	4.05
1942	187,383	60,475	1,857	97	249,812	1.96	490,000	163,847	2.99
1943	201,173	59,976		317	261,466	1.76	460,000	164,057	2.80
1944	218,569	63,137		1,645	283,351	1.82	516,000	170,673	3.02
1945	211,237	69,091	23	3,277	283,628	1.76	499,000	172,055	2.90
1946	248,398	63,002	8,492	9,939	329,831	1.56	515,000	173,599	2.97
1947	247,006	64,501	6,157	23,682	341,346	1.35	461,000	174,546	2.64
1948	279,712	65,370	2,436	11,079	358,597	1.28	459,000	175,781	2.61
1949	326,108	76,772		15,144	418,024	1.28	535,000	176,243	3.04
1950	307,028	84,000	6,358	36,858	434,244	1.35	586,000	180,814	3.24
1951	333,754	89,018	14,001	27,103	463,876	1.27	589,000	182,776	3.22
1952	393,304	101,199	26,728	28,231	549,462	1.18	648,000	184,901	3.50
1953	343,777	106,069	6,210	21,333	477,389	1.15	549,000	185,756	2.96
1954	363,565	112,806	7,769	24,463	508,603	1.18	600,000	187,612	3.20
1955	368,393	117,056	22,869	24,819	533,137	1.16	618,000	191,568	3.23
1956	348,241	110,689	9,600	25,391	493,921	1.06	524,000	190,976	2.74
1957	382,209	120,106	1,999	47,599	551,913	1.01	557,000	189,792	2.93
1958	366,507	117,818	4,491	45,520	534,336	1.02	545,000	188,928	2.88
1959	387,982	118,814	9,489	26,705	542,990	1.03	559,000	188,721	2.96
1960	411,004	114,283	15,603	35,196	576,086	1.04	599,000	188,341	3.18
1961	429,099	131,162	15,233	43,458	618,952	1.03	638,000	189,421	3.37
1962	469,317	130,218	12,348	31,539	643,422	1.02	656,000	190,866	3.44
1963	448,737	139,332	1,265	27,318	616,652	1.00	617,000	192,324	3.21
Totals	$8,343,173	$2,454,330	$188,366	$525,897	$11,511,766		$16,316,000		$95.84
					29 Year Average 1935 - 1963		$ 563,000		$ 3.30
					10 Year Average 1954 - 1963		$ 591,300		$ 3.11

TABLE 1A

EASTERN IRRIGATION DISTRICT

BREAKDOWN OF OPERATION AND MAINTENANCE COSTS

Year	(1) Salaries & Wages Amount	%	(2) Heavy Equipment Amount	%	(3) Materials & Supplies Amount	%	(4) Transportation Amount	%	(5) Irrigation Pumps Amount	%	(6) Premises Amount	%	(7) Other Amount	%	(8) Total
1935 (a)	$ 27,299	29	$ 4,386	5	$ 41,878	44	$		$		$ 1,434	1	$20,584	21	$ 95,581
1936	72,193	52	26,831	19	32,765	24							6,325	5	138,114
1937	96,138	63	16,813	11	23,102	15							16,184	11	152,237
1938	63,533	52	17,178	14	12,258	10	12,968	11					16,636	13	122,573
1939	104,369	56	21,399	11	29,754	16	15,962	9			26	0	14,903	8	186,413
1940 (b)	43,909	25	13,870	8	(b) 89,553	51	12,632	7	1,943	1	3,353	2	11,072	6	176,332
1941 (b)	48,019	24	9,441	5	(b) 106,968	54	13,102	6	2,409	1	3,688	2	15,793	8	199,420
1942	88,209	47	35,857	19	21,371	11	14,717	8	2,485	1	2,913	2	21,831	12	187,383
1943	89,497	44	49,670	25	18,672	9	25,912	13	1,823	1	3,393	2	12,206	6	201,173
1944	90,691	41	59,242	27	29,660	14	25,442	12	1,912	1	4,836	2	6,786	3	218,569
1945	91,895	44	45,629	22	29,452	14	28,622	13	2,542	1	2,712	1	10,385	5	211,237
1946	100,445	40	63,279	26	38,546	16	31,961	12	2,250	1	3,763	2	8,154	3	248,398
1947	106,471	43	66,314	28	32,520	13	31,195	12	2,220	1	2,900	1	5,386	2	247,006
1948	120,140	43	53,825	19	53,403	19	31,877	12	2,688	1	6,749	2	11,030	4	279,712
1949	129,808	40	71,381	22	59,777	18	35,399	11	4,841	1	9,700	3	15,202	5	326,108
1950	116,145	38	69,789	23	56,344	18	38,623	13	4,783	2	7,485	2	13,859	4	307,028
1951	131,357	39	86,309	26	60,017	18	39,173	12	2,882	1	7,748	2	6,268	2	333,754
1952	128,475	33	119,816	30	77,908	20	44,443	11	2,711	1	9,420	2	10,531	3	393,304
1953	134,232	39	79,714	23	69,525	20	43,611	13	2,972	1	5,600	2	8,123	2	343,777
1954	142,236	39	80,209	22	75,467	21	43,852	12	4,507	1	6,964	2	10,330	3	363,565
1955	143,102	39	99,042	27	57,128	16	48,479	13	5,546	1	5,290	1	9,806	3	368,393
1956	135,529	39	88,367	25	62,334	18	42,922	13	4,611	1	7,071	2	7,407	2	348,241
1957	149,034	39	94,626	25	72,175	19	40,045	10	4,503	1	5,895	2	15,931	4	382,209
1958	154,892	42	84,004	23	63,311	17	35,435	10	5,623	1	10,022	3	13,220	4	366,507
1959	169,384	44	102,783	26	51,731	13	35,907	9	6,140	2	10,988	3	11,049	3	387,982
1960	174,643	43	112,044	27	60,247	15	36,302	9	6,221	1	11,433	3	10,114	2	411,004
1961	180,689	42	128,320	30	57,375	13	32,394	8	8,065	2	13,427	3	8,829	2	429,099
1962	183,532	39	152,482	32	65,619	14	32,695	7	8,966	2	14,751	3	11,272	3	469,317
1963	173,366	38	142,551	32	68,011	15	29,458	7	7,316	2	13,623	3	14,412	3	448,737
															$8,343,173

NOTE (a) — Period May 1 to Dec. 31.
NOTE (b) — Salaries and wages of maintenance staff included in materials and supplies for 1940 and 1941.

EASTERN IRRIGATION DISTRICT

BREAKDOWN OF ADMINISTRATION AND GENERAL EXPENSES

Year	(1) Salaries & Wages		(2) Pensions		(3) Interest and Bank Charges		(4) Taxes and Maintenance of Bldgs.		(5) Insurance		(6) Travel		(7) Other		(8) Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	
1935 (a)	$ 19,403	63	$		$ 39	0	$ 4,269	14	$ 2,014	6	$ 474	2	$ 4,729	15	$ 30,928
1936	28,554	64			50	0	4,298	10	2,258	5	3,634	8	6,122	13	44,916
1937	26,797	58			75	0	7,113	15	1,910	4	3,976	9	6,629	14	46,500
1938	28,290	61			135	0	3,814	8	2,429	5	4,345	9	7,858	17	46,871
1939	28,549	60			46	0	4,662	10	2,164	4	4,162	9	8,348	17	47,931
1940	37,533	60			495	1	7,902	12	2,593	4	4,744	7	9,832	16	63,099
1941	30,996	52			264	0	5,766	10	3,474	6	4,504	8	14,187	24	59,191
1942	31,822	53			300	0	7,256	12	4,096	7	4,409	7	12,592	21	60,475
1943	32,479	54			160	0	6,951	12	4,634	8	3,541	6	12,211	20	59,976
1944	35,655	56			413	1	6,467	10	4,449	7	3,233	5	12,920	21	63,137
1945	39,372	57			759	1	9,116	13	4,905	7	3,184	5	11,755	17	69,091
1946	36,907	59			695	1	5,586	9	5,994	9	2,010	3	11,810	19	63,002
1947	36,547	57			906	1	6,301	10	5,970	9	2,713	4	12,064	19	64,501
1948	35,275	54			620	1	6,862	11	7,264	11	2,909	4	12,440	19	65,370
1949	36,980	48	6,241	8	1,192	2	8,054	11	7,561	10	4,077	5	12,667	16	76,772
1950	39,928	48	6,572	8	1,879	2	10,197	12	8,263	10	5,838	7	11,323	13	84,000
1951	43,369	48	6,560	7	3,464	4	11,189	13	8,801	10	4,976	6	10,659	12	89,018
1952	49,568	49	7,799	8	6,384	6	9,684	10	9,475	9	5,760	6	12,529	12	101,199
1953	51,796	49	6,418	6	8,256	8	10,180	9	8,667	8	5,125	5	15,627	15	106,069
1954	48,912	44	7,162	6	10,117	9	11,694	10	8,740	8	4,839	4	21,342	19	112,806
1955	52,726	45	8,051	7	11,297	10	13,328	11	9,086	8	5,465	5	17,103	14	117,056
1956	51,352	46	6,704	6	12,474	11	8,962	8	9,549	9	6,319	6	15,329	14	110,689
1957	53,582	45	7,874	7	16,290	13	9,753	8	9,973	8	5,694	5	16,940	14	120,106
1958	52,772	45	8,833	8	14,658	12	9,739	8	10,345	9	4,735	4	16,736	14	117,818
1959	54,420	46	10,524	9	12,037	10	12,146	10	10,014	8	4,960	4	14,713	13	118,814
1960	53,094	47	10,415	9	9,850	9	9,672	8	10,317	9	5,088	4	15,847	14	114,283
1961	59,646	45	11,446	9	17,604	13	11,028	9	10,079	8	5,716	4	15,643	12	131,162
1962	60,139	46	7,459	6	18,930	14	10,394	8	9,835	8	5,681	4	17,780	14	130,218
1963	66,455	48	10,607	8	18,562	13	12,883	9	9,435	7	5,294	4	16,096	11	139,332
															$2,454,330

NOTE (a) — For period May 1 to Dec. 31.

TABLE 1C

EASTERN IRRIGATION DISTRICT

ANALYSIS OF EXPENDITURES FOR ADDITIONS & BETTERMENTS

Year	PORTION EXCLUDED FROM TABLE 1				PORTION INCLUDED IN TABLE 1			
	(1) New Development	(2) Improvements To Service	(3) For Major Structures	(4) Sub Total	(5) Other Itemized Betterments	(6) Miscellaneous Betterments	(7) Sub Total	(8) Total
1935	$	$ 20,464	$	$ 20,464	$	$	$	$ 20,464
1936	9,505	36,900		46,405				46,405
1937	17,840	8,822		26,662	600		600	27,262
1938	56,768	3,495		60,263	5,149		5,149	65,412
1939	37,282			37,282	5,532		5,532	42,814
1940	39,164			39,164		2,885	2,885	42,049
1941	25,054			25,054		1,018	1,018	26,072
1942	19,459			19,459		97	97	19,556
1943	49,088			49,088		317	317	49,405
1944	48,654			48,654		1,645	1,645	50,299
1945	11,134			11,134		3,277	3,277	14,411
1946	628			628		9,939	9,939	10,567
1947	3,817			3,817	14,755	8,927	23,682	27,499
1948	2,222	2,728		4,950		11,079	11,079	16,029
1949	3,029	24,935	5,271	33,235	2,478	12,666	15,144	48,379
1950	18,765		12,700	31,465	13,092	23,766	36,858	68,323
1951	3,199			3,199	8,462	18,641	27,103	30,302
1952	17,304		6,742	24,046	11,604	16,627	28,231	52,277
1953	23,875		7,269	31,144		21,333	21,333	52,477
1954	13,883	1,896		15,779	4,213	20,250	24,463	40,242
1955	4,370		3,180	7,550	4,483	20,336	24,819	32,369
1956			27,856	27,856	7,456	17,935	25,391	53,247
1957		116,428	23,745	140,173 (a)	18,747	28,852	47,599	187,772 (a)
1958	1,311			1,311	4,830	40,690	45,520	46,831
1959		114,008	6,916	120,924	1,714	24,991	26,705	147,629
1960		243,583 (b)	110,107	353,690	10,357	24,839	35,196	388,886 (b)
1961	3,365	19,496	7,766	30,627	18,324	25,134	43,458	74,085
1962	13,695	1,248	9,902	24,845	12,116	19,423	31,539	56,384
1963	2,991	2,760	2,024	7,775	6,651	20,667	27,318	35,093
TOTALS	$426,402	$596,763	$223,478	$1,246,643	$150,563	$375,334	$525,897	$1,772,540

NOTES: (a) Includes $132,454 for Rock Lake Reservoir built by P.F.R.A. and not shown in E.I.D. Annual Reports.

(b) Includes $160,253 expended by E.I.D. on Antelope Creek Fill and shown in their Annual Reports under "Replaced Capital Assets", but included here as the fill is not a major structure.

EASTERN IRRIGATION DISTRICT

TABLE 2

ANNUAL COST FOR REPLACEMENT OF MAJOR STRUCTURES AND BRIDGES

Structure Number	Structure	Estimated Cost of Replacement 1963 (dollars)	Estimated Remaining Life in 1963 (years)	Estimated Total Life for Depreciation Purposes (years)	ANNUAL COST OF REPLACEMENT Straight Line Depreciation Rate	ANNUAL COST OF REPLACEMENT Annual Amount (dollars)
1	Bassano Dam — immediate repair	$ 1,800,000		50	.02	$ 36,000
	— replace	6,000,000	25	75	.0133	80,000
	NORTH BRANCH CANAL					
2	Headgates	41,000	4-8	50	.02	820
3	Bassano Check	35,000	4-8	50	.02	700
4	Secondary "A" Check	33,000	4-8	50	.02	660
5	Stepped Drop	34,000	2-5	50	.02	680
6	Crawling Valley Flume	250,000	5-10	40	.025	6,250
	EAST BRANCH CANAL					
7	Headgates	63,000	4-8	50	.02	1,260
8	Antelope Creek Canal Check	39,000	45-50	50	.02	780
9	Antelope Creek Spillway	90,000	2-5	50	.02	1,800
10	Kitsim Canal Check Drop	45,000	45-50	50	.02	900
11	Kitsim Canal Headgates	35,000	45-50	50	.02	700
12	Cassils Canal Check	37,000	2-5	50	.02	740
13	Cassils Canal Syphon	75,000	35-40	40	.025	1,875
14	Distributary 10 Check	35,000	40-45	50	.02	700
15	Lake Newell Inlet	52,000	2-5	50	.02	1,040
	SPRINGHILL CANAL					
16	Headgates	53,000	2-5	50	.02	1,060
17	Lathom Flume	350,000	4-8	40	.025	8,750
18	Secondary "A" Check	38,000	4-8	50	.02	760
19	Chute	50,000	40-50	50	.02	1,000
20	Rock Lake (Secondary C) Check	35,000	45-50	50	.02	700
21	Distributary 13 Check	35,000	45-50	50	.02	700
22	Distributary 14 Check	35,000	45-50	50	.02	700
23	Distributary 16 Check	33,000	40-45	50	.02	700
24	Secondary F Check and Turnout	35,000	5-10	50	.02	660
25	Rock Lake Turnout Secondary C	20,000	45-50	50	.02	700
26	Rock Lake Turnout Secondary D	20,000	45-50	50	.02	400
27	Nigger John Syphon	50,000	4-8	40	.02	400
28	Nigger John Spillway	36,000	4-8	50	.025	1,250
					.02	720
	BANTRY CANAL					
29	Headgates	125,000	4-8	50	.02	2,500
30	Brooks Aqueduct	1,000,000	2-5	50	.02	20,000
31	West-North Bantry Split	47,000	5-10	50	.02	940
32	Check to Cowoki Reservoir	39,000	40-50	50	.02	780
33	Cowoki Reservoir Outlet	33,000	25-35	50	.02	660
34	One Tree Reservoir Spillway	33,000	2-5	50	.02	660
	ROLLING HILLS CANAL					
35	Rolling Hills Reservoir Inlet	90,000	4-8	50	.02	1,800
36	Rolling Hills Reservoir Outlet	41,000	25-35	50	.02	820
37	Secondary A Check	27,000	45-50	50	.02	540
	BRIDGE STRUCTURES					
	Provincial	158,000		40	.025	3,950
	County	291,000		40	.025	7,275
	E.I.D.	285,000		30	.033	9,500
	TOTALS	$11,623,000				$202,130

TABLE 3

EASTERN IRRIGATION DISTRICT

ANNUAL COST FOR REPLACEMENT OF BUILDINGS & DWELLINGS

1. Capital Expenditures by E.I.D. 1935-1963

			Net Increase or (Decrease)		
Year	Additions	Reductions Through Sale or Demolition	Actual	Conversion Factor	1963 Base
1935	$ 2,013	$	$ 2,013	3.33	$ 6,703
1936		9,941	(9,941)	3.22	(32,010)
1937	9,111	4,360	4,751	2.86	13,588
1938	4,576		4,576	2.86	13,087
1939	1,547		1,547	2.86	4,424
1940	5,423		5,423	2.78	15,076
1941	7,437		7,437	2.38	17,700
1942	6,770		6,770	1.96	13,269
1943	7,385		7,385	1.76	12,998
1944		6,300	(6,300)	1.82	(11,466)
1945	375		375	1.76	660
1946	1,077		1,077	1.56	1,680
1947		3,940	(3,940)	1.35	(5,319)
1948	1,544	534	1,010	1.28	1,293
1949	9,350	700	8,650	1.28	11,072
1950	12,544	1,715	10,829	1.35	14,619
1951	24,598	5,598	19,000	1.27	24,130
1952	43,006	117	42,889	1.18	50,609
1953	19,567	83	19,484	1.15	22,407
1954	6,972	3,765	3,207	1.18	3,784
1955	1,481		1,481	1.16	1,718
1956	1,577	490	1,087	1.06	1,152
1957	1,857	525	1,332	1.01	1,345
1958	15,936	2,975	12,961	1.02	13,220
1959	5,479	288	5,191	1.03	5,347
1960	3,550	4,700	(1,150)	1.04	(1,196)
1961	98	4,491	(4,393)	1.03	(4,525)
1962	6,448	593	5,855	1.02	5,972
1963	10,888	190	10,698	1.00	10,698
Totals	$210,609	$51,305	$159,304		$212,035

2. Depreciated Value of Buildings at Time of Transfer to E.I.D. by C.P.R.	$109,320	3.33	$364,035
Total Valuation of Buildings 1963 Base			$576,070
		Say	$576,000
Annual depreciation to provide for replacement in 50 years			$ 11,500

TABLE 4

EASTERN IRRIGATION DISTRICT

SUMMARY OF ANNUAL COST

A. For Project Operation

	ANNUAL COST	
	Amount	**Cost/Acre**
1. Past expenditures by District (See Table 1)	$634,670	$3.30
2. Allowance for canal maintenance not carried out	4,000	.02
Total for Operation	$638,670	$3.32

B. To Provide for Replacement of Non-Permanent Works

	Amount	Cost/Acre
1. Major structures and bridges (See Table 2)	$202,130	$1.05
2. Buildings (See Table 3)	11,500	.06
Total	$213,630	$1.11
GRAND TOTAL	$852,300	$4.43

NOTE:

All per acre costs based on 1963
irrigable area — 192,324 acres.